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## EARTHQUAKE OF AUGUST 27, 1904.

By Prof. C. F. MARVIN.

An earthquake was recorded by the Omori seismograph at the Weather Bureau on August 27, beginning at 5<sup>h</sup> 4<sup>m</sup> 57<sup>s</sup> p. m., seventy-fifth meridian time.

The disturbance was evidently of great severity, that is to say, the amplitude of motion of the earth particle (5.35 mm.) during the maximum waves was fully seventeen times as great as in the case of any earthquake thus far recorded at the Weather Bureau. So far as known, however, the earthquake was not felt by any individuals in Washington, or at any other point in the United States. The record is exceedingly clear and perfect in all details. A small section of the middle portion of the sheet, showing the maximum waves of the principal portion, is reproduced in fig. 1.

The MONTHLY WEATHER REVIEW for June, 1903, at page 271, gives a description of the seismograph.

The following table gives the times of the principal features of the record. The north and south component of horizontal motion only was recorded.

*Earthquake of August 27, 1904, seventy-fifth meridian time.*

	<i>h.</i>	<i>m.</i>	<i>s.</i>	<i>h.</i>	<i>m.</i>	<i>s.</i>
First preliminary tremors began.....	5	4	57 p. m.			
Second phase began.....	5	12	07 p. m.			
Second preliminary tremors began.....	5	15	59 p. m.			
Principal portion began.....	5	21	39 p. m.			
Principal portion ended.....	5	26	42 p. m.			
End of earthquake.....	6	24	41 p. m.			
Duration of first preliminary tremors.....				0	11	2
Duration of second preliminary tremors.....				0	5	40
Duration of principal portion.....				0	5	3
Total duration of earthquake.....				1	19	44
Average complete period of 4 large initial waves, principal portion.....						24.1
Average complete period for 4½ large waves at end of principal portion.....						14.9
Period of pendulum.....						26.0
Maximum double amplitude of actual displacement of earth at seismograph.....				5.35	mm.	
Magnification of record.....				10	times.	

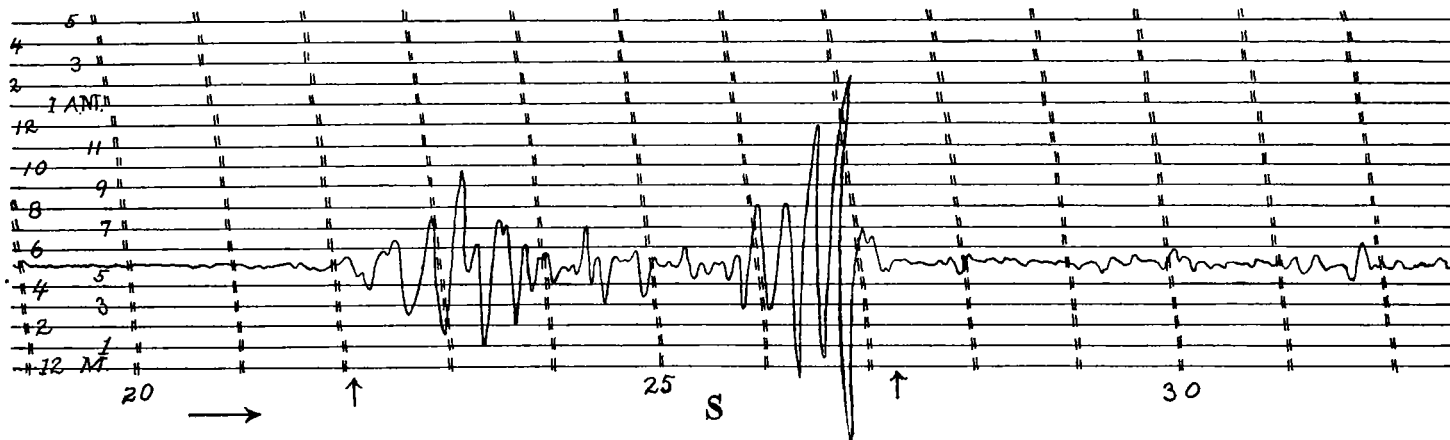


FIG. 1.—Principal of portion of record of the earthquake of August 27, 1904.

The Superintendent of the United States Coast and Geodetic Survey furnishes the following information in regard to this earthquake:

A letter from Mr. P. H. Dike, the Magnetic Observer at Vieques, Porto Rico, contains the following data regarding the earthquake of August 27, 1904, as recorded on the Bosch Omori seismograph at that place. The seismograph records both the north-south and east-west components of horizontal motion.

The time is reduced to seventy-fifth meridian time.

	N. S.	E. W.
	<i>h. m. s.</i>	<i>h. m. s.</i>
Time of beginning.....	5 08 40	5 08 48
Time of maximum .....	5 40 06	5 36 06
Time of ending.....	6 58 31	6 49 19
Maximum double amplitude of actual displacement of earth at seismograph.....	4.2 mm.	3.3 mm.
Period of pendulum (kept constant) .....	26.3 sec.	24.7 sec.
Ratio of magnification.....	10	10

A letter from Mr. W. F. Wallis, Magnetic Observer at Cheltenham, Md., states that the magnetograph records show the disturbance very plainly, it being especially well marked in the horizontal and vertical intensity traces, both on Eschenhagen and Adie instruments.

Five distinct shocks can be recognized, the approximate times of which are: 5<sup>h</sup> 06<sup>m</sup>; 5<sup>h</sup> 23<sup>m</sup>; 5<sup>h</sup> 26<sup>m</sup>; 5<sup>h</sup> 31<sup>m</sup>, and 6<sup>h</sup> 21<sup>m</sup>, seventy-fifth meridian time, counting from 0<sup>h</sup> at midnight to 24 hours.

A newspaper report at the time states that a violent earth-

quake was felt at San Martin in the State of Oaxaca, Mexico, accompanied by "deafening subterranean rumblings."

#### DR. GEORGE W. HAY.

Dr. George W. Hay, observer and translator in the Weather Bureau, died at Washington, D. C., August 11, 1904. Doctor Hay was born at Conesville, N. Y., August 10, 1847. In December, 1874, he enlisted in the Signal Corps of the Army, in which service he remained until the organization of the Weather Bureau, when he was transferred to the civil establishment, in which he continued until his death, the two periods extending almost thirty years. Doctor Hay was a man of high personal integrity, thoroughly conscientious in the discharge of his duties, unobtrusive in manner, kindly and affable in disposition.

#### CORRIGENDA.

MONTHLY WEATHER REVIEW for July, 1904, p. 329, under "Weather of the Month" for "in charge of Division of Meteorological Records" read "Chief of Division of Meteorological Records."

MONTHLY WEATHER REVIEW for July, p. 316, column 1, 17th line, under fig. 2, for  $\frac{b+J'}{L}$  read  $\frac{b+J}{L}$ .

MONTHLY WEATHER REVIEW for April, p. 173, column 2, paragraph 2, line 6, for "38½" read "58½."

#### NOTES AND EXTRACTS.

##### THE PRIMARY AND SECONDARY RAINBOWS.

When the sunlight falls upon a drop of rain, even though the raindrop be rapidly falling, yet so quick is the action of light that it goes through the drop and passing on enters the eye of the observer, as though the drop were stationary. Now a drop of water can reflect sunlight as nicely as does a mirror. It can also refract or bend the rays of light as does a glass prism. If a prism or a piece of broken glass be properly held in the sunshine, the many different colors that are produced may be perceived. There is the whole range through red, green, yellow, and blue up to the indigo and violet, that constitutes a spectrum. When a ray of light passes through a drop of water it produces a spectrum somewhere so that one will see it and enjoy the beautiful colors if his eye is in the right position. Now, when the sun's rays, *SS*, fall upon a drop at *A*<sub>1</sub>, some of them enter the drop at *a*, are reflected at *b* back to the point *c*, where they come out and form the spectrum, *vr*. If the observer is at *O* he may see the violet part of the spectrum. There is another drop, *A*<sub>2</sub>, a little way above *A*<sub>1</sub>, which produces a similar spectrum, but the red ray is the one that comes down toward the observer at *O* so that he sees the violet ray below and the red ray above with a beautiful spectrum between them. Now, somewhere above these drops there may be another one, *A*<sub>3</sub>, so located that a ray from the sun may enter this drop at the point *m*, be reflected twice within the drop at *o*, *p*, and issue from it at *q* in such a direction that red rays may enter the observer's eye at *O*. A little above *A*<sub>3</sub> may be another drop, *A*<sub>4</sub>, into which a similar ray of sunlight enters and after two internal reflections sends its violet ray to the observer's eye at *O*.

Thus it will happen that the drops between *A*<sub>1</sub> and *A*<sub>2</sub>, although themselves invisible, send to the observer at *O* the bright beams of light that make up a bright spectrum or band of colors having the violet below and the red above. This is called the primary rainbow, because it is the brightest and the one most frequently seen. The drops between *A*<sub>3</sub> and *A*<sub>4</sub> send to the observer at *O* the other set of colors forming the secondary rainbow, having the red below and the violet above. These latter colors are not quite so brilliant as those of the

primary, principally because the light was reflected twice within the drops and much of its color thereby lost. The secondary rainbow is not seen so often as the primary, because the sun has to be lower down near the horizon in order to bring it out perfectly.

The reason why these two rainbows have their colors arranged in opposite directions is not because the secondary is a reflection of the primary bow, as is often said. There is nothing in the sky like a mirror from which the primary bow could be reflected. If we look into a basin or pond of water we may, indeed, see the primary bow reflected, but in this case not only are the colors turned upside down, but the whole arch of the bow is inverted. Now, the arch of the secondary rainbow is not inverted, but is parallel to that of the primary; it is only the order of the colors that is inverted, and this inversion is the result of the two reflections within the drops *A*<sub>3</sub> and *A*<sub>4</sub> by which the path of the ray crosses on itself. The one reflection inside of drops *A*<sub>1</sub> and *A*<sub>2</sub> gives a direct path in which the lines do not cross each other. It is the crossing of the lines *Sm* and *qr*, and not the reflection of the arch as a whole, that inverts the order of every individual color spectrum.

In addition to the color of the brilliant primary rainbow, there are sometimes beautiful fringes of color close along the edges of the primary, and these are called supernumerary bows.

The primary rainbow is formed of arcs of circles whose radii vary from 39.6° for the violet to 42.1° for the red. Its center is at a point directly opposite the sun as seen by the observer. If the sun is in the horizon the bow will be a complete semicircle, having its center in the opposite horizon. The higher the sun is above the horizon, so much the lower must the center be below the horizon. If the sun should be 40° above the horizon, then the rainbow would be almost wholly below and we could only see a small bit of color just above the horizon. Therefore, the only time when we can see the rainbow is when the sun is not too high. Consequently, we rarely see them in the middle of the day. Rainbows can be formed only when the sun shines upon rather large drops of water. Very small